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National Bureau of Standards

AUG 21 1947

NOMOGRAPHIC PREDICTIONS OF F2-LAYER FREQUENCIESTHROUGHOUT THE SOLAR CYCLE, FOR JANUARY

The accompanying nomograms present predictions of  $f^{\circ}F_2$  and  $F_2-4000$  muf throughout the solar cycle, for each ten degrees of latitude in each of the three zones of Fig. 1.

These were derived in the manner described in the reports IRPL-R11, "A Nomographic Method for Both Prediction and Observation Correlation of Ionosphere Characteristics", and IRPL-R16, "Predicted F2-Layer Frequencies Throughout the Solar Cycle, for Summer, Winter, and Equinox Season". The method of their use in obtaining  $f^{\circ}F_2$  and  $F_2-4000$  muf is illustrated by the example shown on Fig. 45. The use of these quantities in obtaining the muf for high-frequency radio propagation is discussed in the report IRPL-R16, cited above, and in the IRPL Radio Propagation Handbook, Part 1, p.47 et seq. It is to be noted that the values of  $f^{\circ}F_2$  and  $F_2-4000$  muf obtained by means of these nomograms must be complemented by values of E-layer muf, in the case of transmission paths under 4000 km and by sporadic-E transmission frequencies for all paths, especially those passing near the auroral zones shown in Fig. 1. This is particularly important during times of minimum solar activity.

Values of  $f^{\circ}F_2$  obtained by means of these nomograms should be fairly accurate in the proximity of ionosphere observing stations which have been in operation for a long time, such as those at Washington, D.C., Watheroo, W. Australia, and Huancayo, Peru. Inaccuracy of prediction is most likely in equatorial regions, where the latitude gradient of  $f^{\circ}F_2$  is particularly high, and in the W zone south of Huancayo, Peru ( $12^{\circ}S$ ), where a few ionospheric observations have been made and thus the prediction is based upon observations in other zones.

The small convolutions of the central curves, A, which show the variation of  $f^{\circ}F_2$ , are frequently of doubtful significance, since many of them may be less than the error or prediction. No attempt was made to smooth these out, however, because of lack of exact knowledge of the extent of this error.

Values of  $F_2-4000$  muf obtained from these nomograms are likely to be slightly too high during periods of high sunspot number, since the values of  $F_2-4000$  used in their computation, the average of all available data, were those obtained during years of low solar activity, and there is a slight decrease in these values with increase of sunspot number. It is estimated that the amount of this error, at a sunspot number of 100, is about 5%.



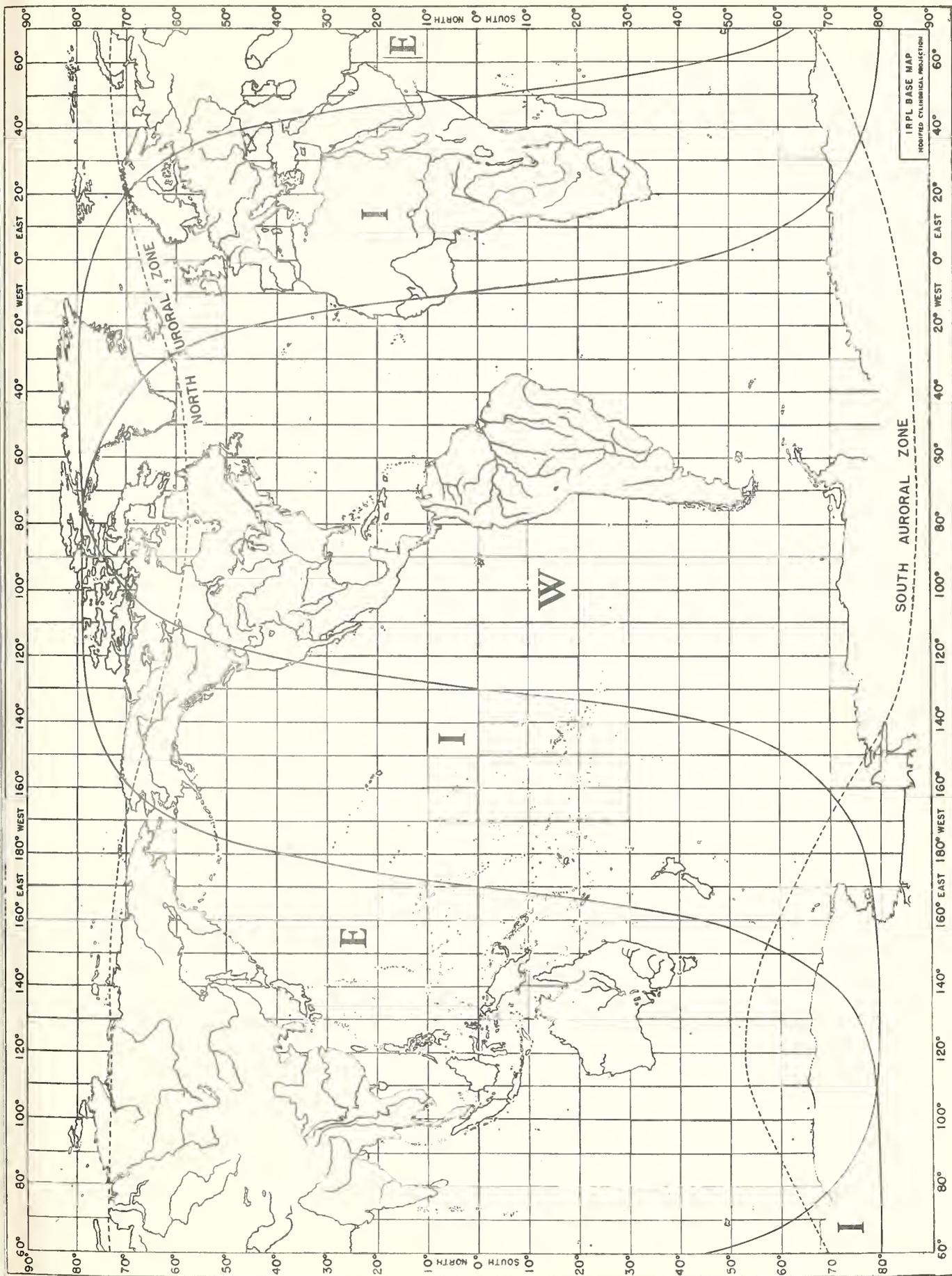
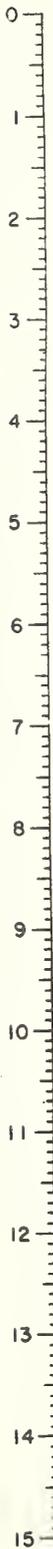
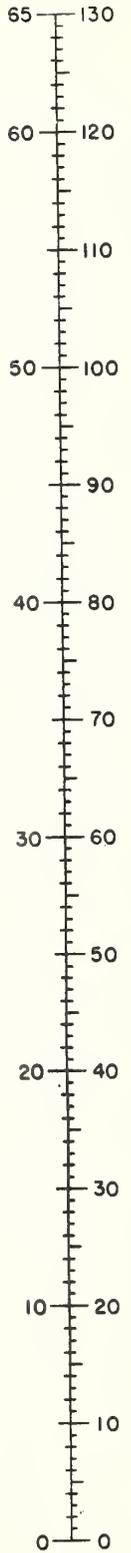


Fig. 1. WORLD MAP SHOWING ZONES COVERED BY PREDICTED CHARTS, AND AURAL ZONES.

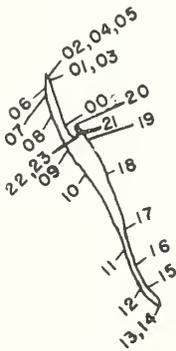
f°F2,  
Mc



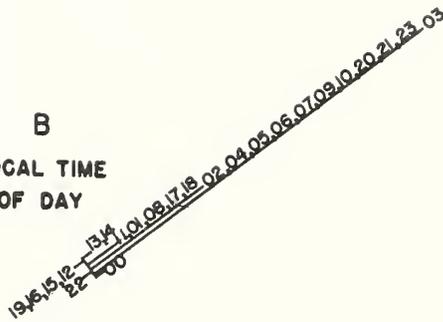
F2-4000 MUF, SUNSPOT  
Mc NUMBER



A  
LOGAL TIME  
OF DAY



B  
LOGAL TIME  
OF DAY



W ZONE

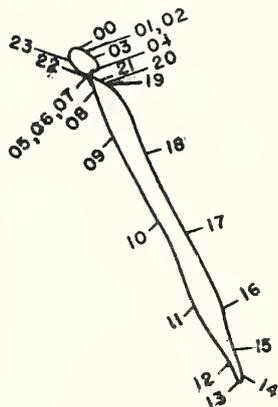
Fig.2.  
JANUARY

80° N

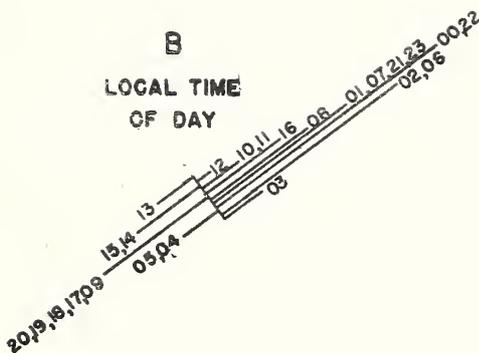
f°F2,  
Mc



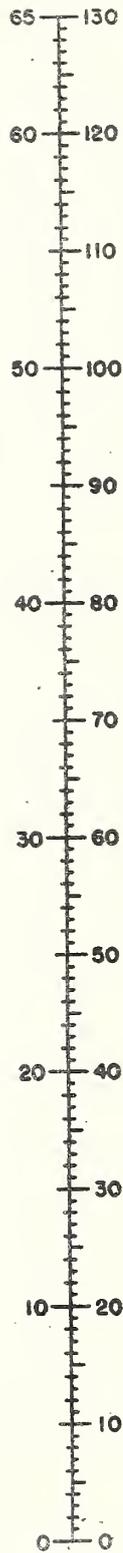
A  
LOCAL TIME  
OF DAY



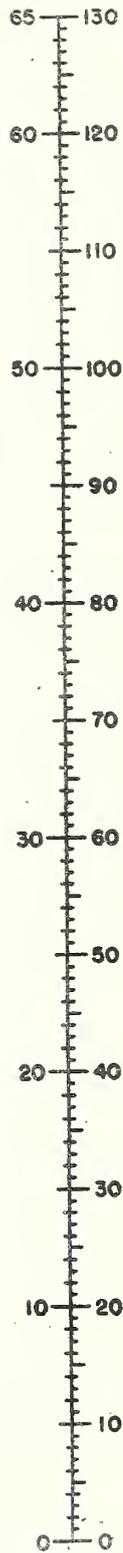
B  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER



W ZONE

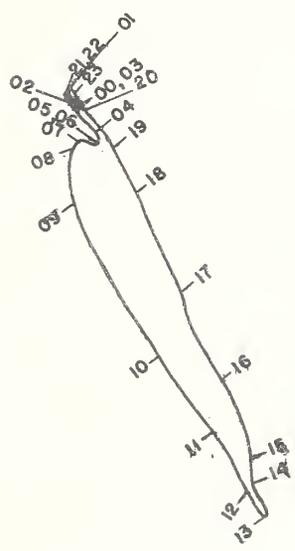
Fig3.  
JANUARY

70° N'

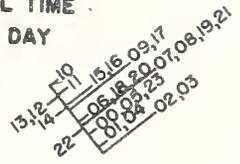
f°F2,  
Mc



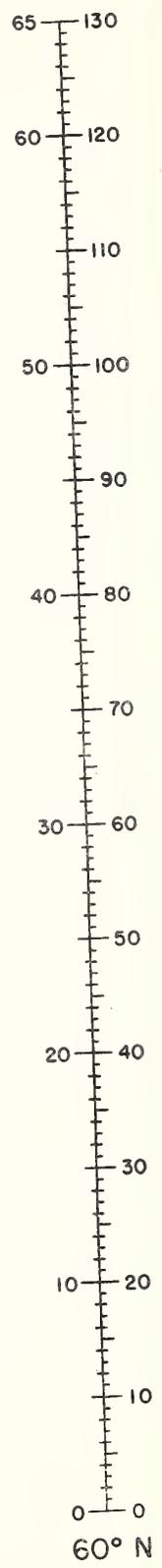
A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



F2-4000 MUF, SUNSPOT  
Mc NUMBER



W ZONE

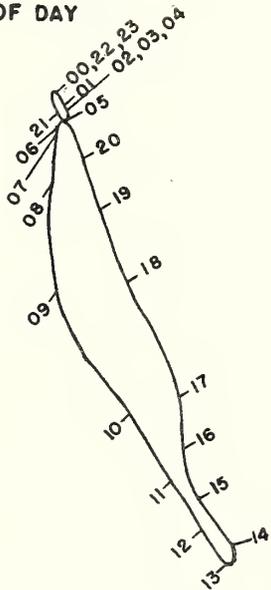
Fig.4.  
JANUARY

f°F2,  
Mc

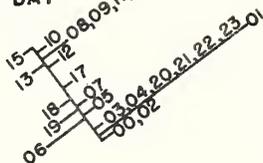


W ZONE

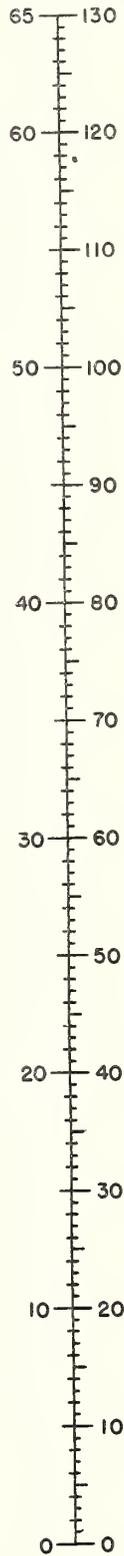
A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc      SUNSPOT  
            NUMBER



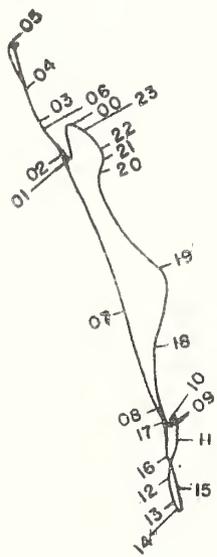
50° N

Fig. 5.  
JANUARY

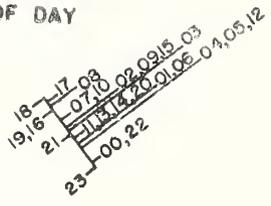
f°F2,  
Mc



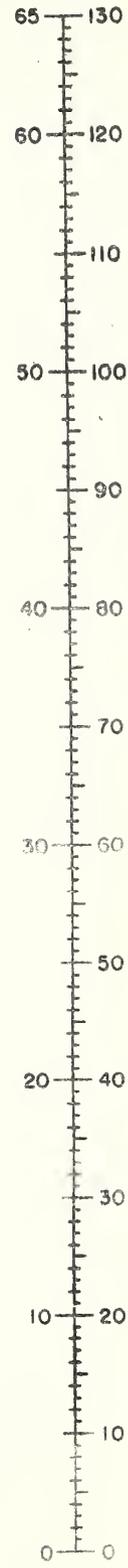
A  
LOCAL TIME  
OF DAY



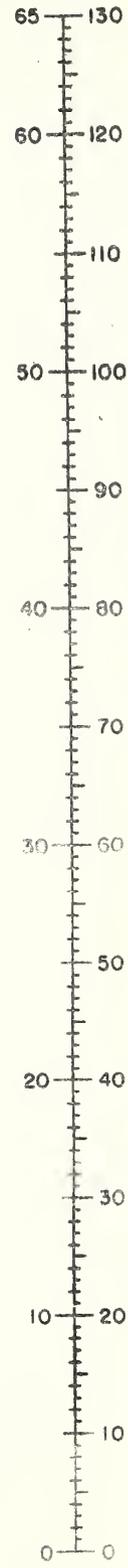
B  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc



SUNSPOT  
NUMBER



W ZONE

Fig. 8.  
JANUARY

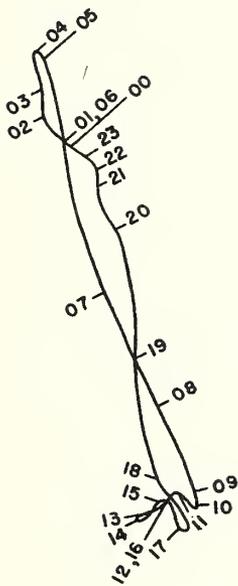
20° N

f°F2,  
Mc

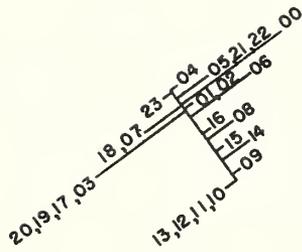


W ZONE

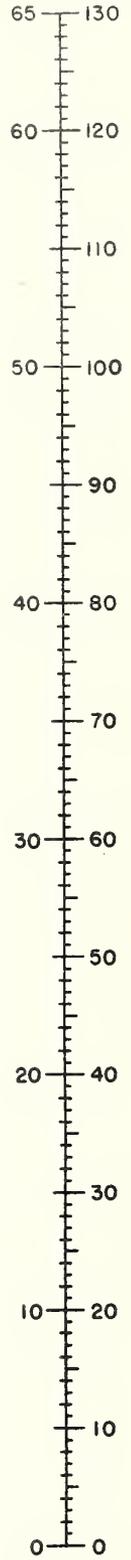
A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc      SUNSPOT  
            NUMBER

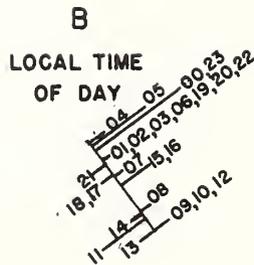
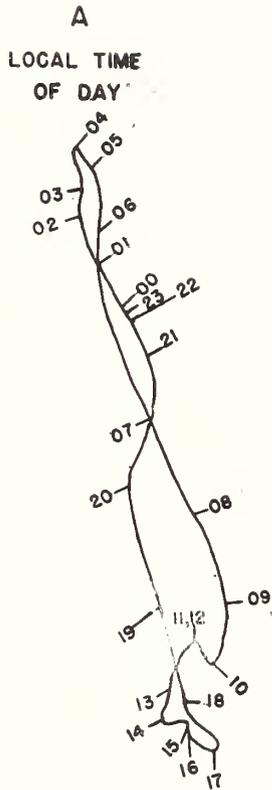
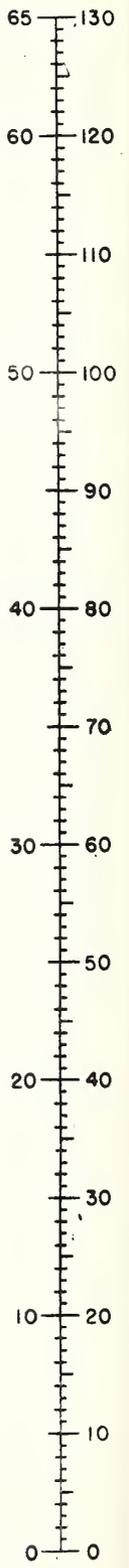


10° N

Fig.9  
JANUARY

$f^{\circ}F_2$ ,  
Mc

F2-4000 MUF, SUNSP  
Mc NUMBE



W ZONE

Fig. 10.  
JANUARY

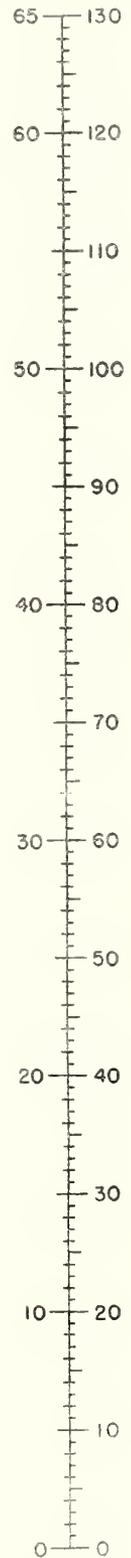
0°

f°F2,  
Mc



W ZONE

F2-4000 MUF,  
Mc      SUNSPOT  
                    NUMBER



10° S

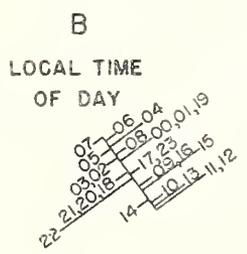
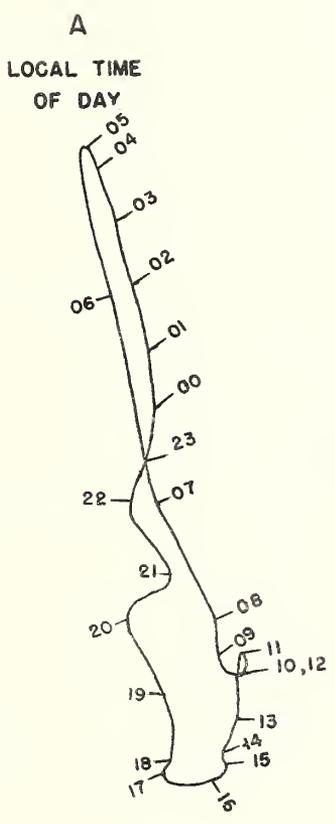
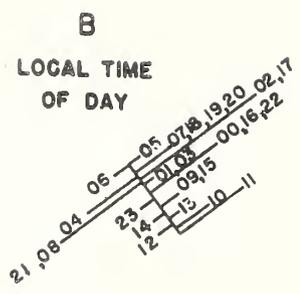
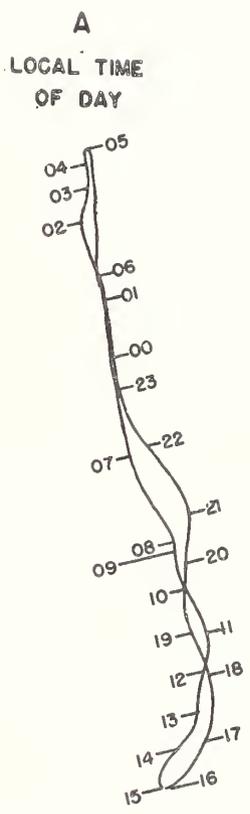
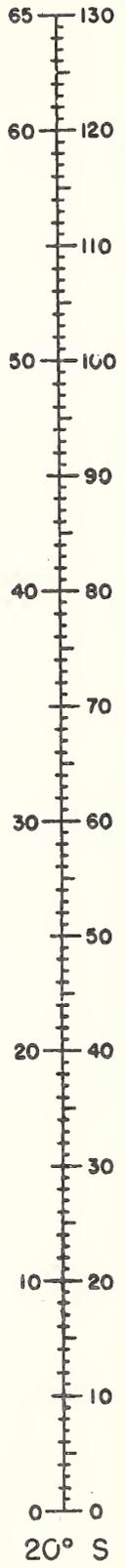


Fig. 11.  
JANUARY

f°F2,  
Mc



F2-4000 MUF, SUNSPOT  
Mc NUMBER



W ZONE

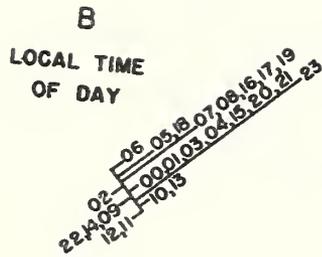
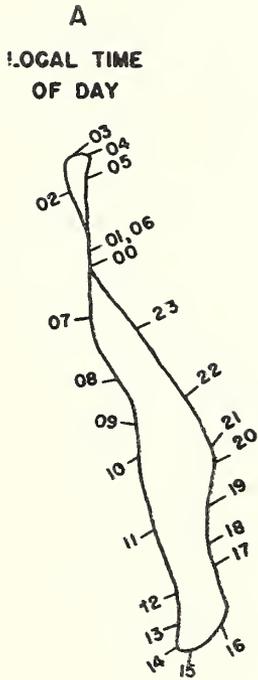
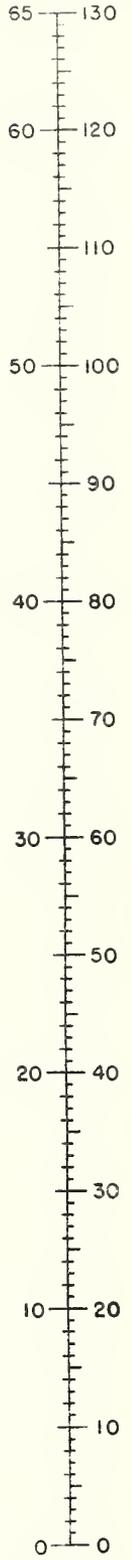
Fig. 12.  
JANUARY

20° S

f°F2,  
Mc



F2-4000 MUF, SUNSPOT  
Mc NUMBER



W ZONE

Fig.13.  
JANUARY

30° S

f°F2,  
Mc

0  
1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15

W ZONE

F2-4000 MUF, SUNSPOT  
Mc NUMBER

65  
60  
50  
40  
30  
20  
10  
0

130  
120  
110  
100  
90  
80  
70  
60  
50  
40  
30  
20  
10  
0

40° S

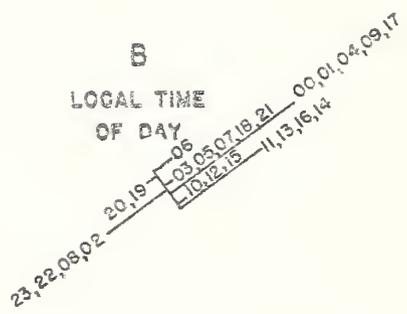
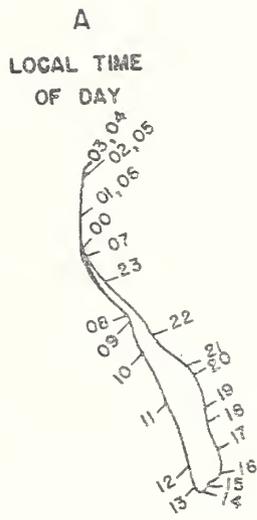


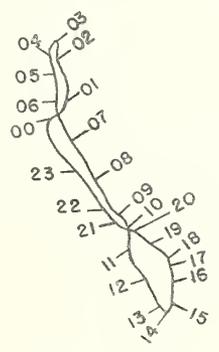
Fig.14  
JANUARY



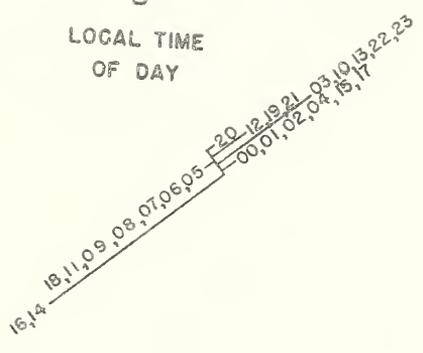
F2-4000 MUF,  
Mc      SUNSPOT  
            NUMBER



A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



W ZONE

Fig. 15.  
JANUARY

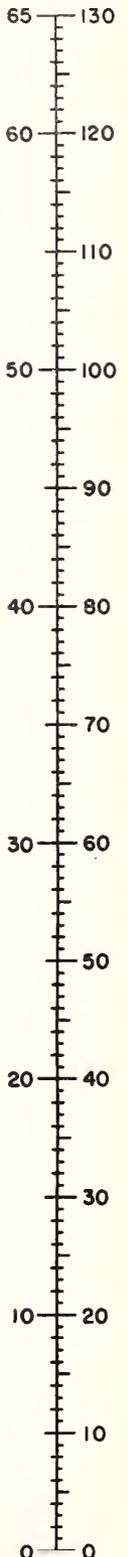
50° S

f°F2,  
Mc



W ZONE

F2-4000 MUF, SUNSPOT  
Mc NUMBER



60° S

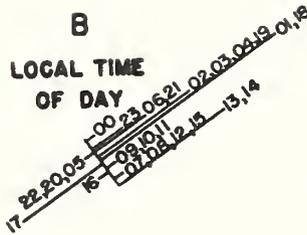
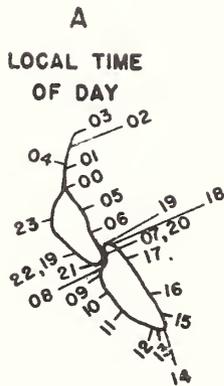
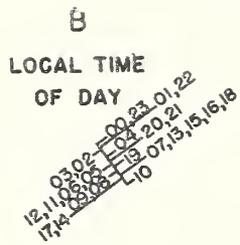
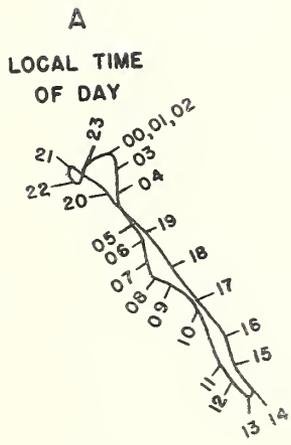
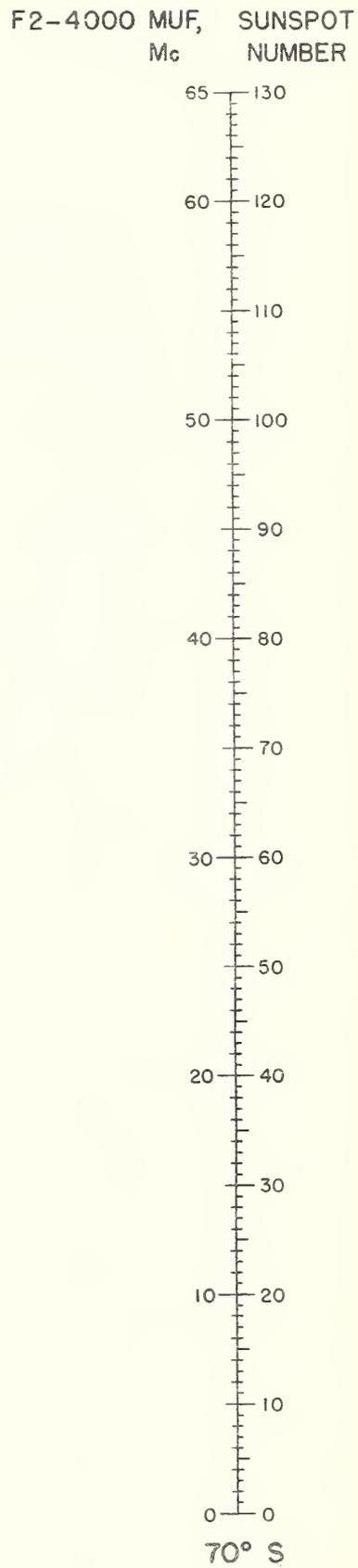
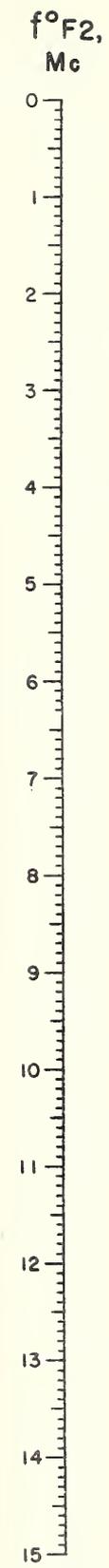


Fig. 16  
JANUARY



W ZONE

Fig.17.  
JANUARY

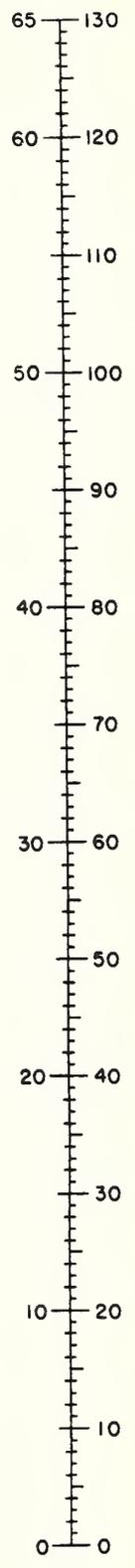
70° S

f°F2,  
Mc



W ZONE,  
I ZONE

F2-4000 MUF, SUNSPOT  
Mc NUMBER



80° S

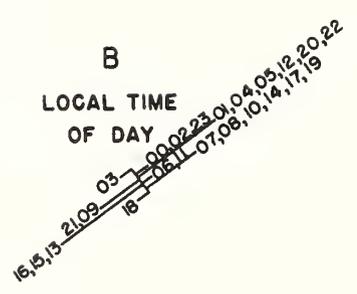
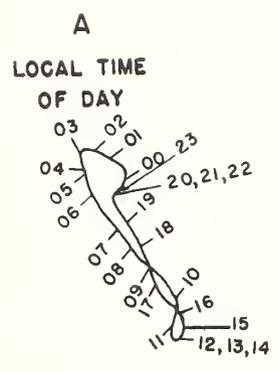
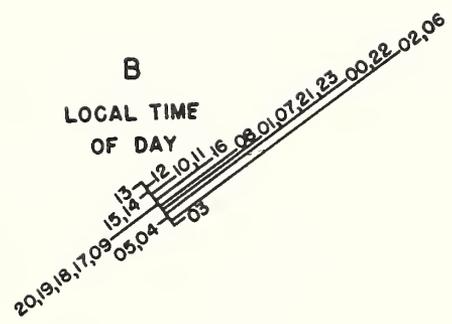
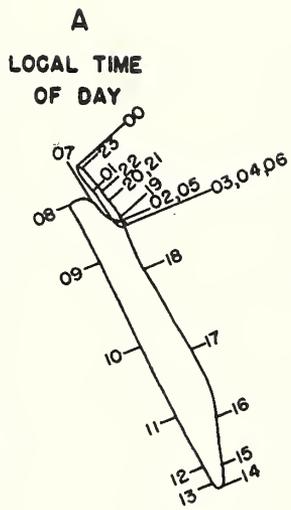


Fig. 18.  
JANUARY

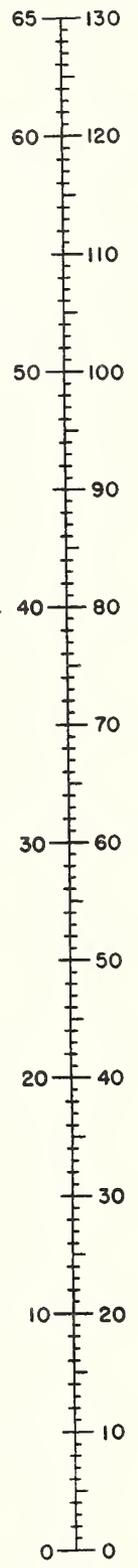
$f^{\circ}F2,$   
Mc



I ZONE



F2-4000 MUF, SUNSPOT  
Mc NUMBER



70° N

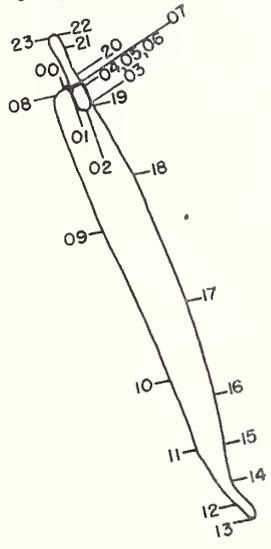
Fig.19.  
JANUARY

f°F2,  
Mc

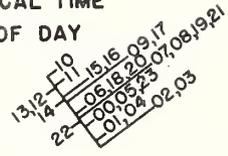


I ZONE

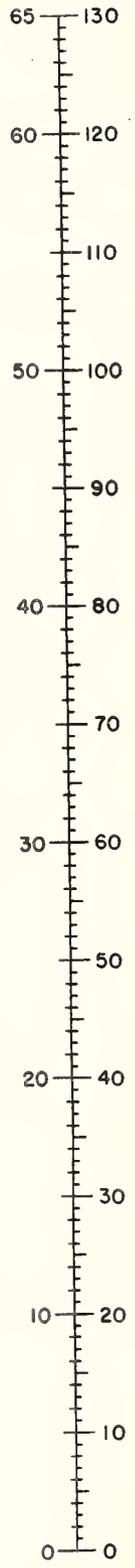
A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



F2-4000 MUF,  
Mc      SUNSPOT  
            NUMBER

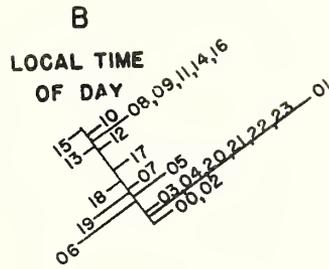
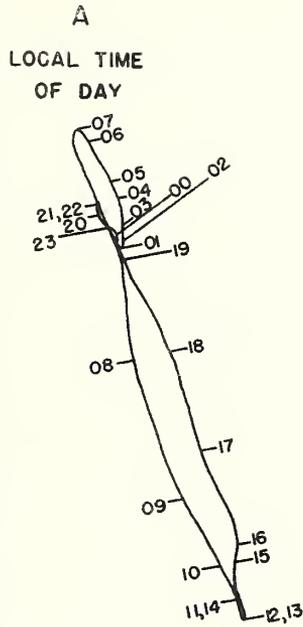
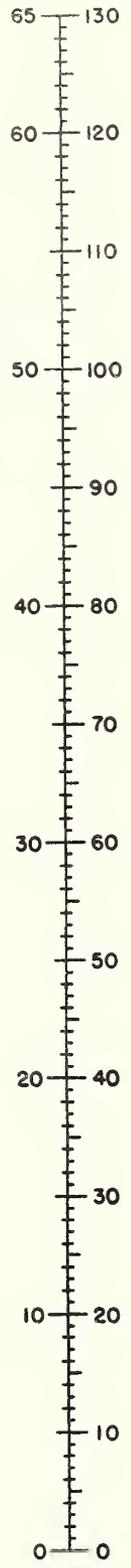
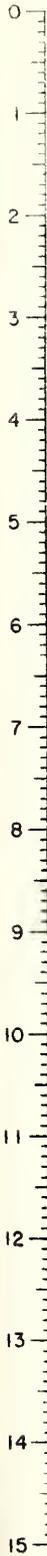


60° N

Fig.20.  
JANUARY

f°F2,  
Mc

F2-4000 MUF,  
Mc      SUNSPOT  
                 NUMBER



I ZONE

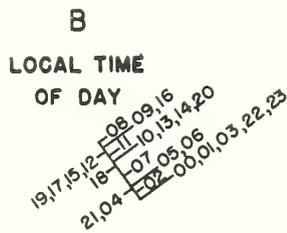
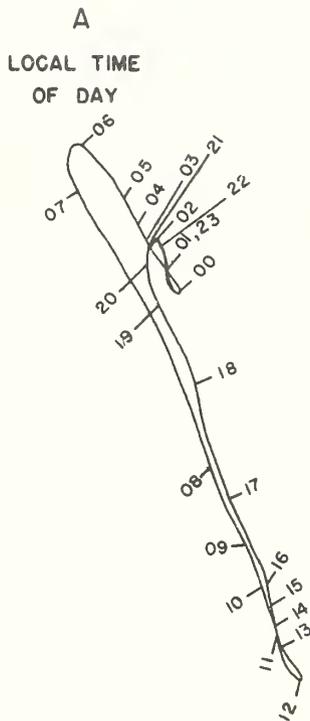
Fig. 21  
JANUARY

50° N

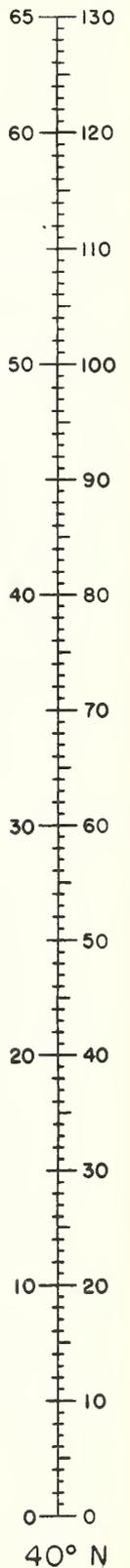
$f^{\circ}F_2$ ,  
Mc



I ZONE



F2-4000 MUF, SUNSPOT  
Mc NUMBER



40° N

Fig.22.  
JANUARY

f°F2,  
Mc

F2-4000 MUF,  
Mc      SUNSPOT  
                    NUMBER

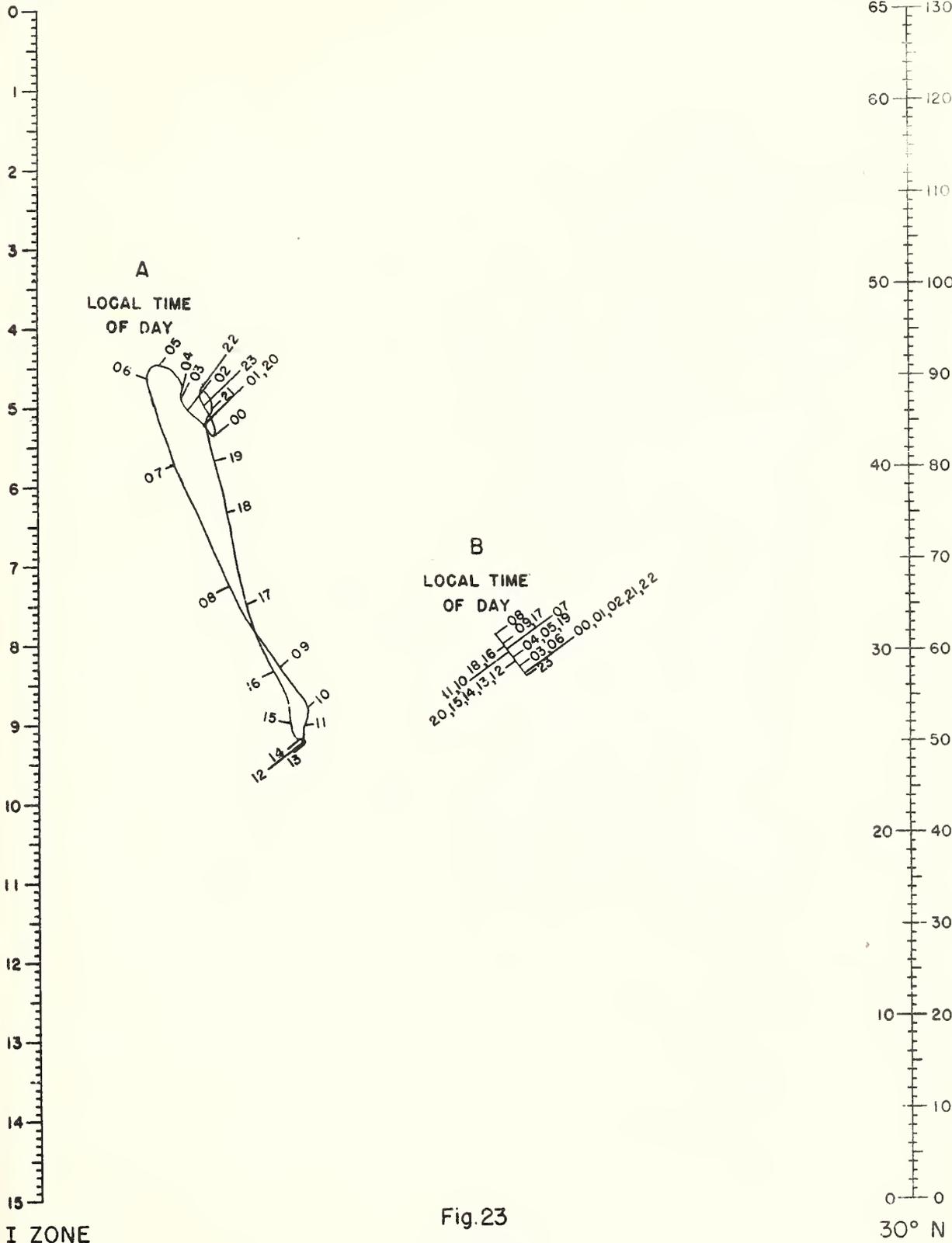
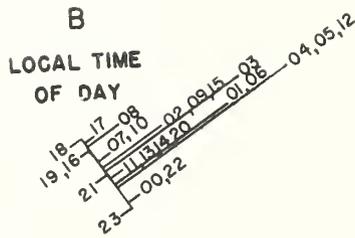
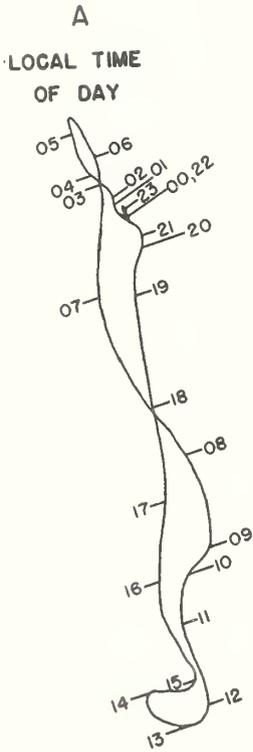
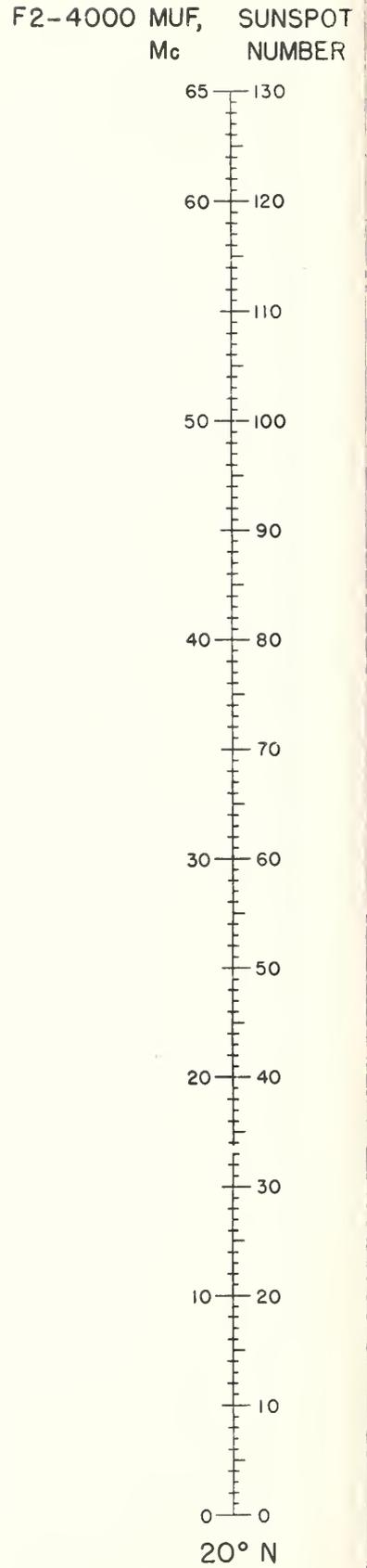


Fig. 23  
JANUARY



I ZONE

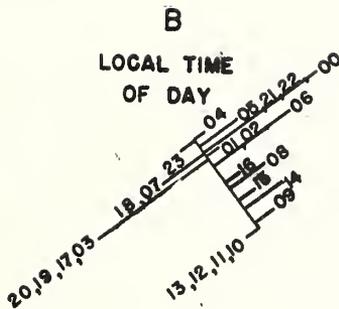
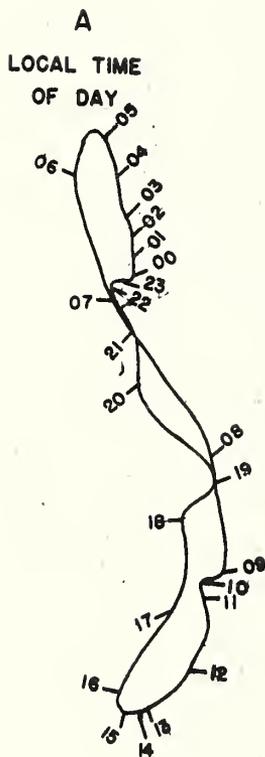
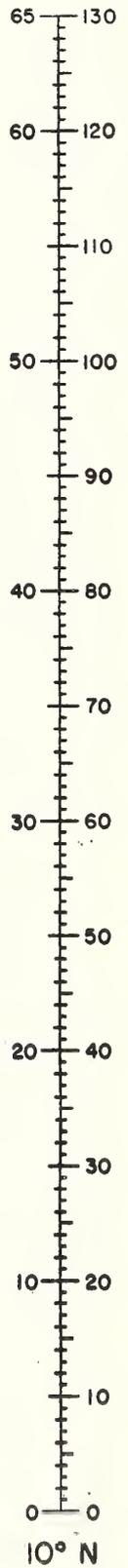
Fig. 24.  
JANUARY

20° N

$f^{\circ}F_2$ ,  
Mc



F2-4000 MUF,  
Mc      SUNSPOT  
NUMBER

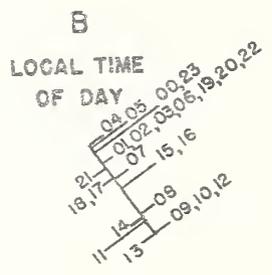
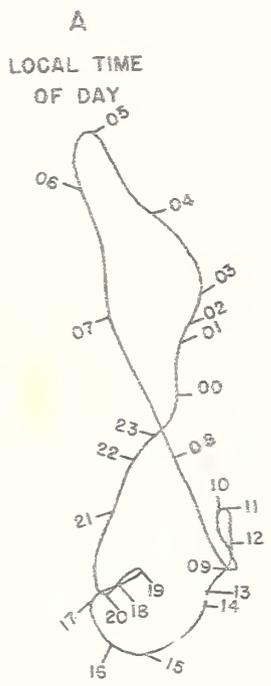
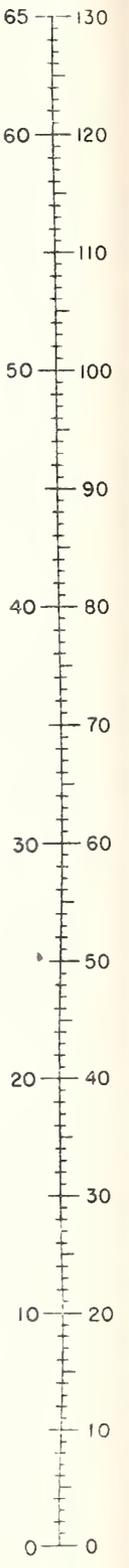


I ZONE

Fig.25.  
JANUARY

$f_oF_2$   
Mc

F2-4000 MUF, SUNSP  
Mc NUMBER

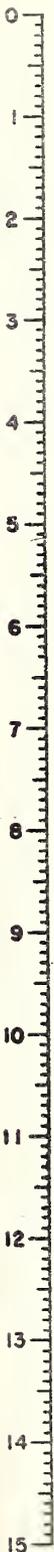


I ZONE

Fig.26.  
JANUARY

U<sup>o</sup>

f°F2,  
Mc



I ZONE

F2-4000 MUF,  
Mc      SUNSPOT  
            NUMBER

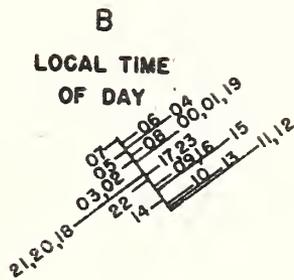
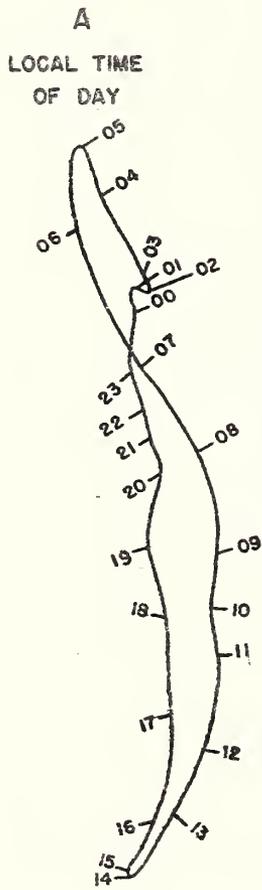
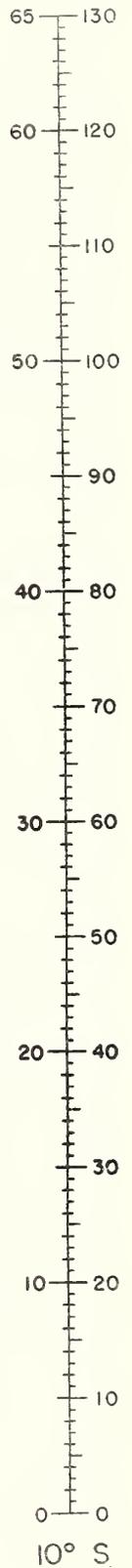


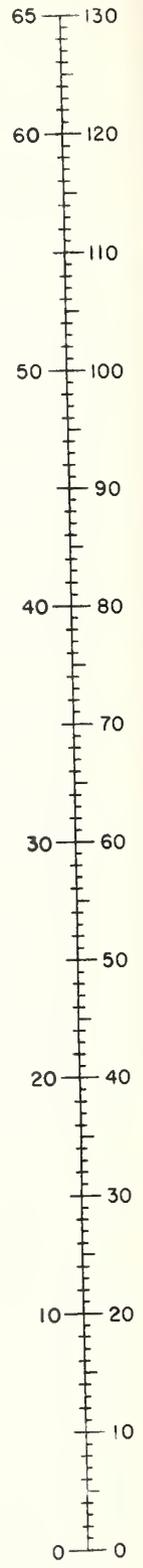
Fig.27.  
JANUARY

f°F2,  
Mc



I ZONE

F2-4000 MUF, SUNSPOT  
Mc NUMBER



20° S

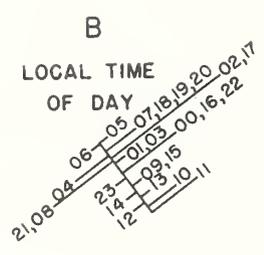
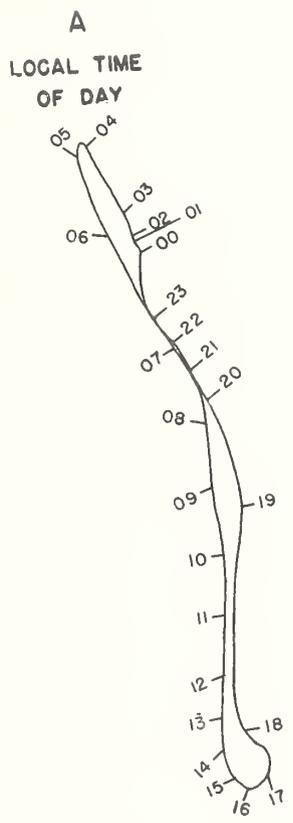
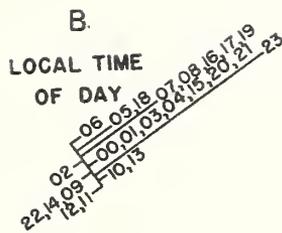
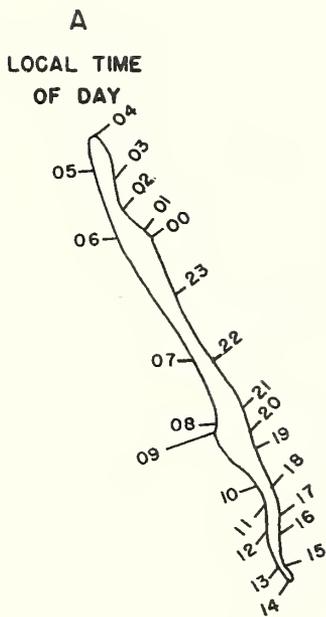
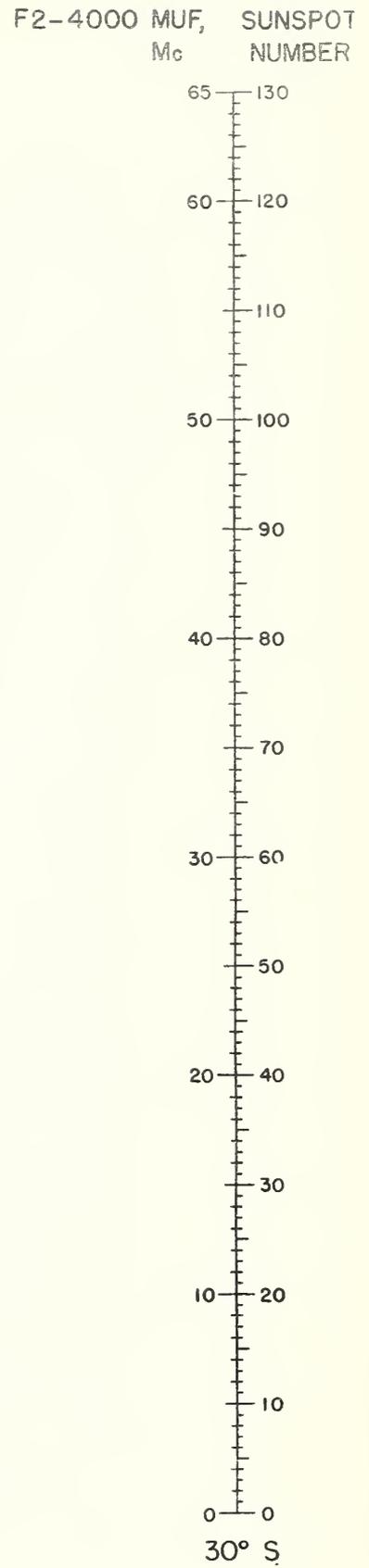


Fig.28.  
JANUARY



I ZONE

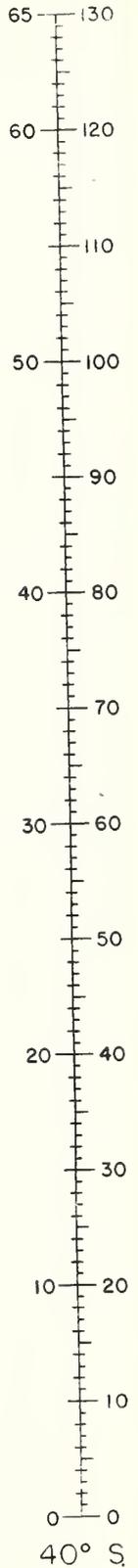
Fig.29.  
JANUARY

$f^{\circ}F_2$ ,  
Mc



I ZONE

F2-4000 MUF, SUNSPOT  
Mc NUMBER



40° S

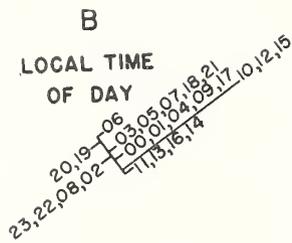
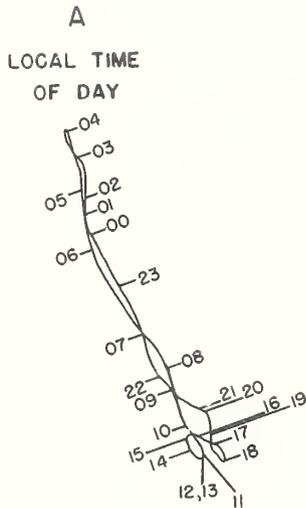
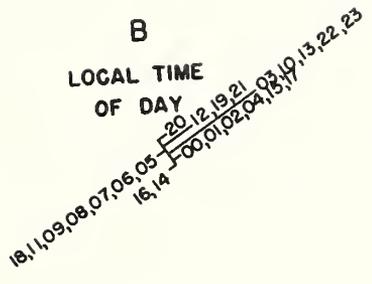
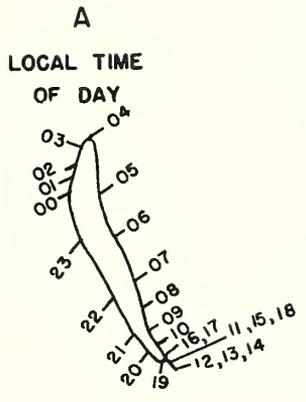
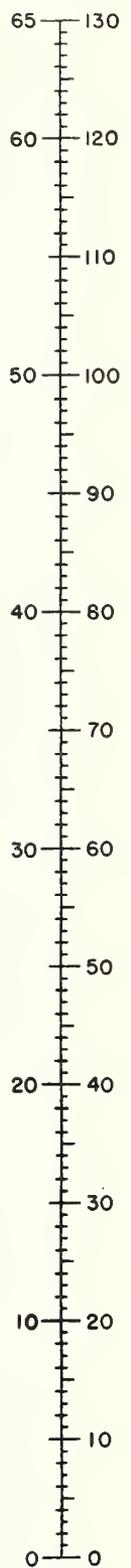


Fig.30.  
JANUARY

F2-4000 MUF, SUNSPOT  
Mc NUMBER

f°F2,  
Mc

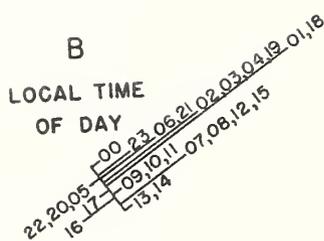
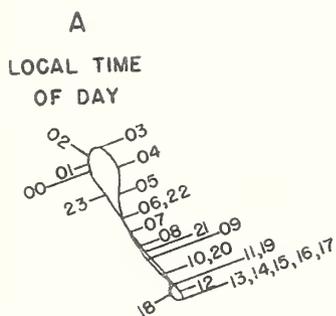


I ZONE

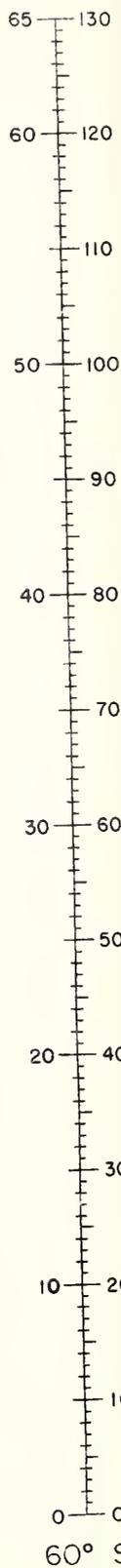
Fig. 31.  
JANUARY

50° S

$f^{\circ}F_2$ ,  
Mc



F2-4000 MUF,  
Mc

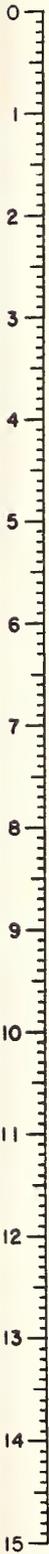


I ZONE

Fig.32.  
JANUARY

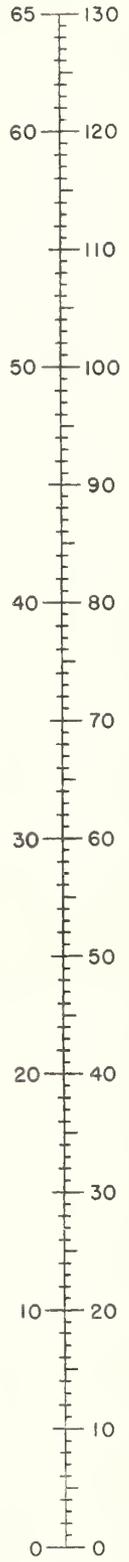
60° S

f°F2,  
Mc



I ZONE

F2-4000 MUF, SUNSPOT  
Mc NUMBER



70° S

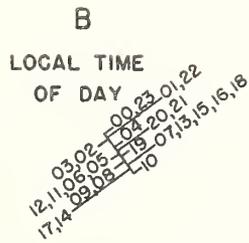
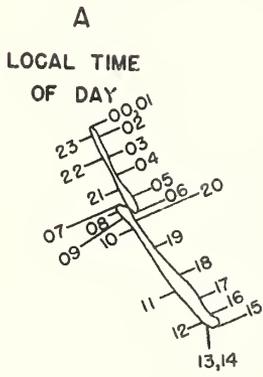


Fig.33.  
JANUARY

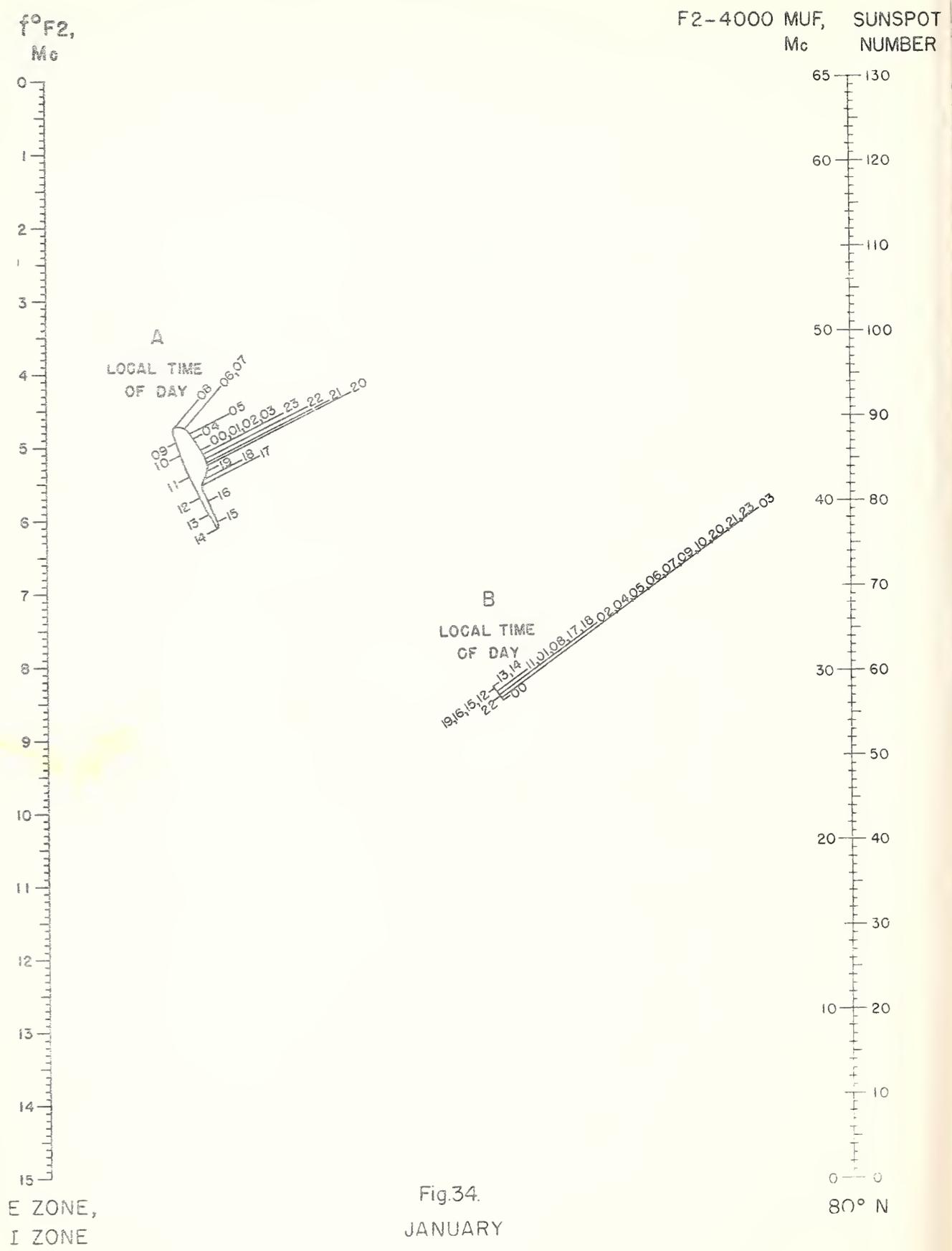
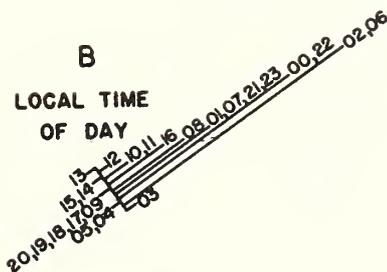
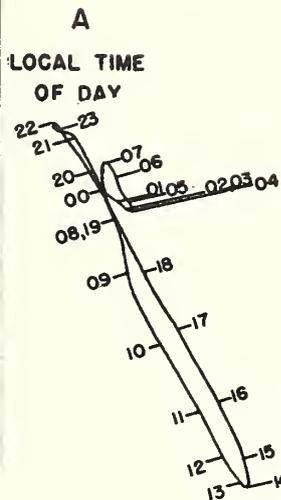
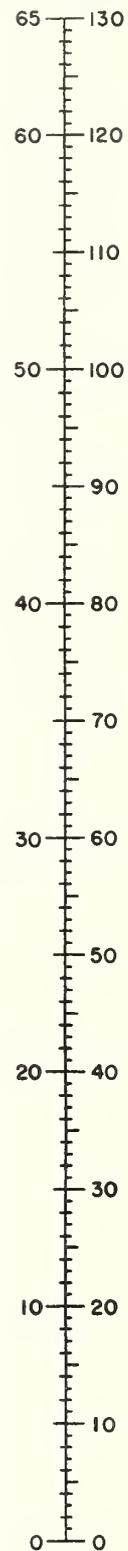


Fig.34.  
JANUARY

f°F2,  
Mc

F2-4000 MUF,  
Mc      SUNSPOT  
                    NUMBER

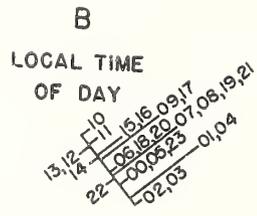
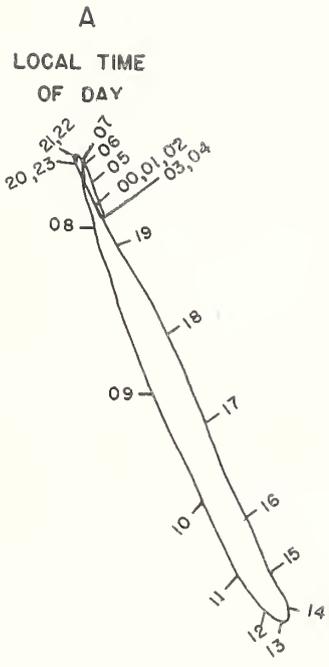
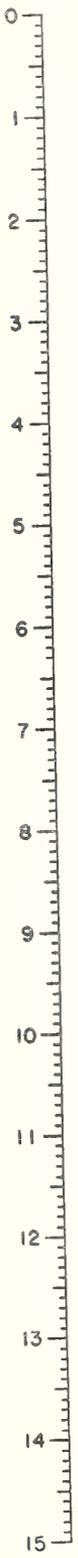


E ZONE

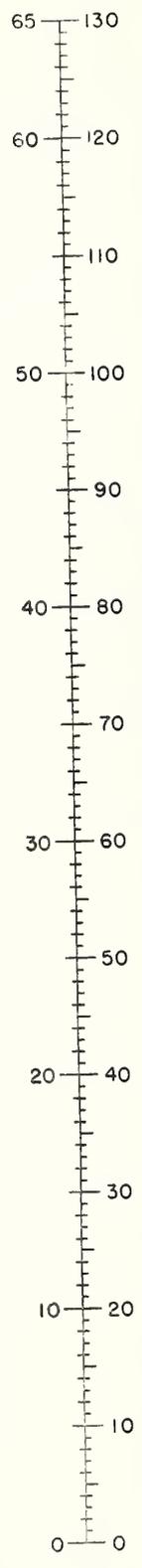
Fig.35.  
JANUARY

70° N

f°F2,  
Mc



F2-4000 MUF, SUNSPOT  
Mc NUMBER



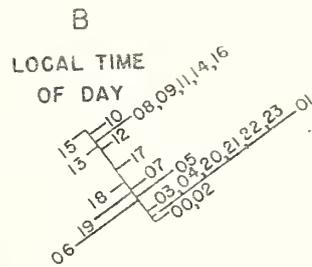
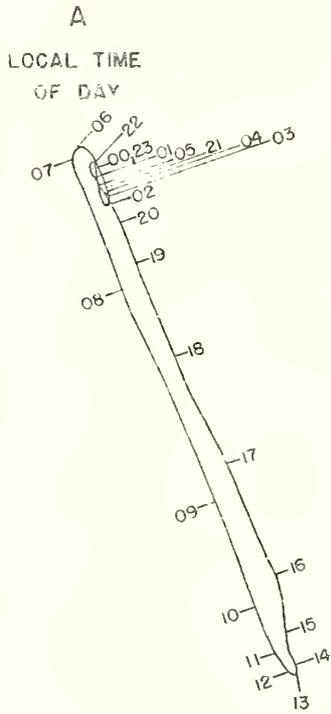
E ZONE

60° N

Fig.36.  
JANUARY

f° F2,  
Mc

F2-4000 MUF,  
Mc      SUNSPOT  
                 NUMBER



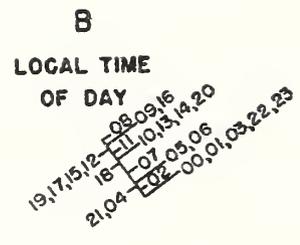
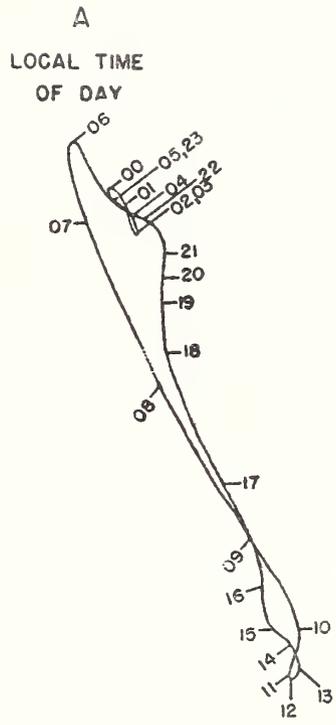
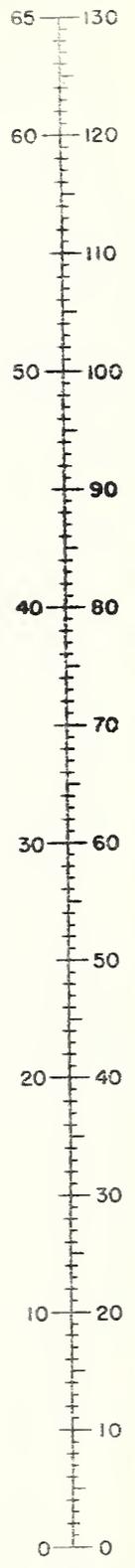
E ZONE

Fig 37  
JANUARY

50° N

f°F2,  
Mc

F2-4000 MUF, SUNSPOT  
NUMBER



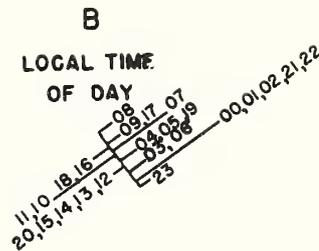
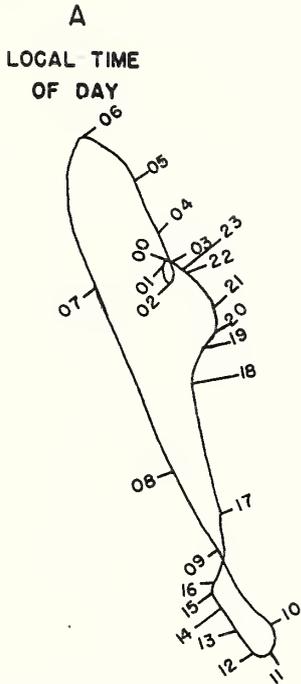
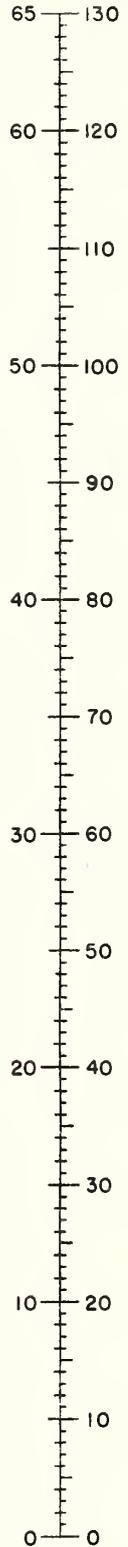
E ZONE

Fig.38.  
JANUARY

40° N

f°F2,  
Mc

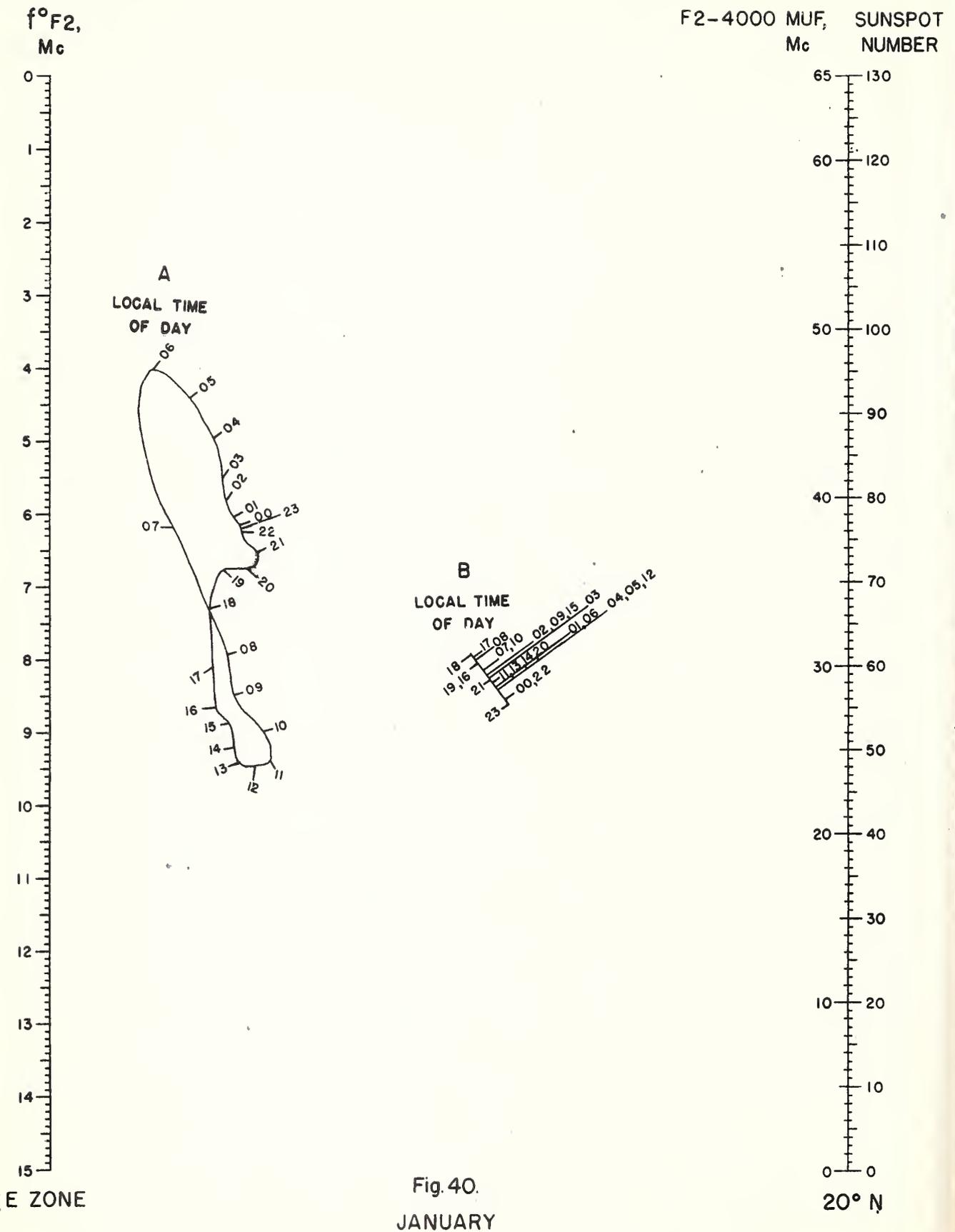
F2-4000 MUF,  
Mc      SUNSPOT  
                    NUMBER



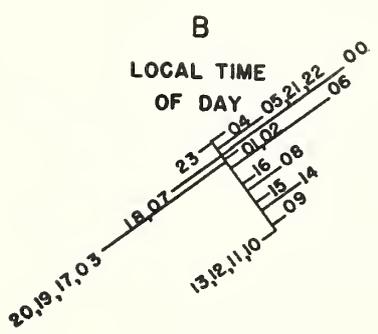
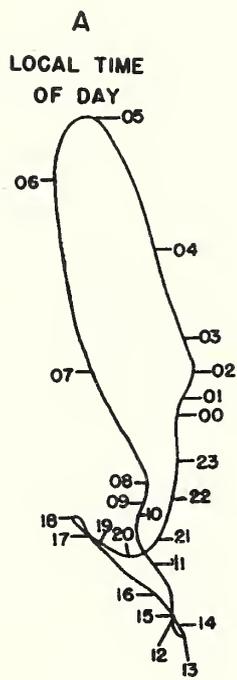
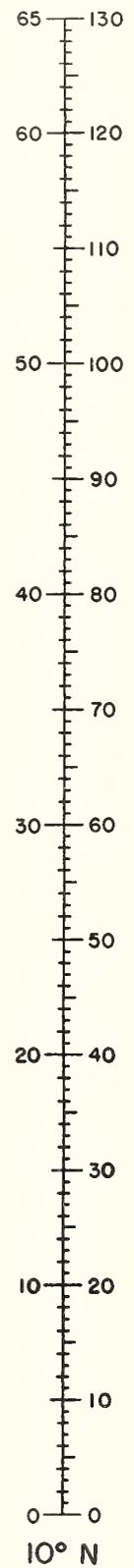
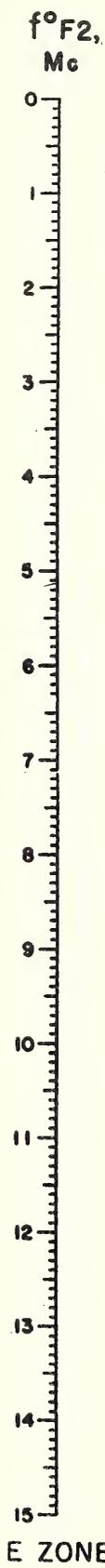
E ZONE

Fig.39.  
JANUARY

30° N



F2-4000 MUF, SUNSPOT  
Mc NUMBER



E ZONE

Fig. 41.  
JANUARY

10° N

$f^{\circ}F_2$ ,  
Mc



E ZONE

F2-4000 MUF, SUNSPOT  
Mc NUMBER

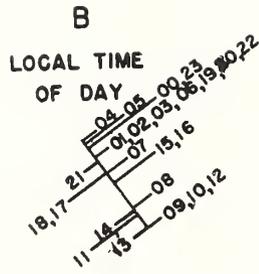
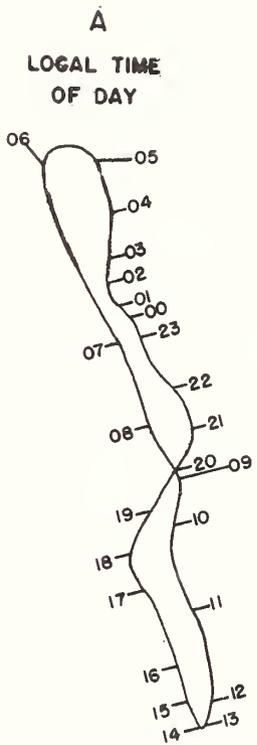
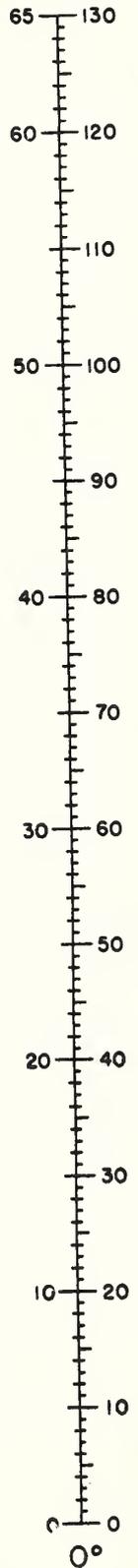
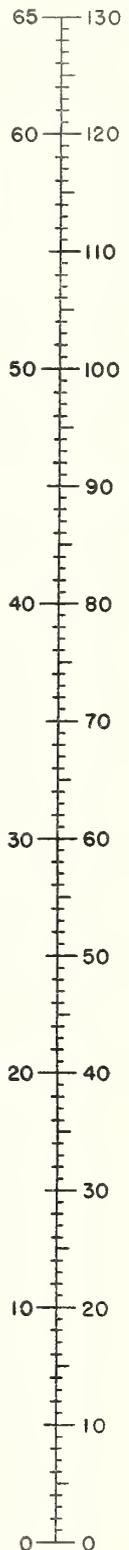


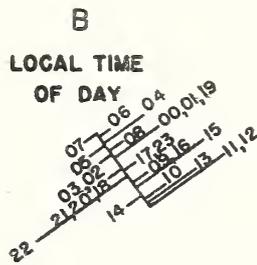
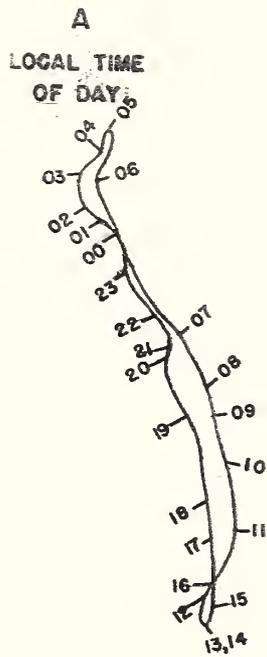
Fig.42.  
JANUARY

f°F2,  
Mc

F2-4000 MUF, SUNSPOT  
Mc NUMBER



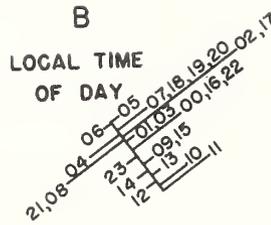
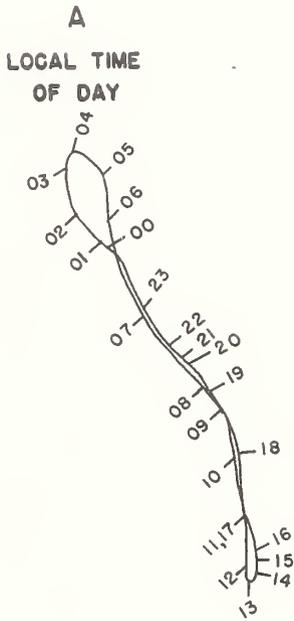
10° S



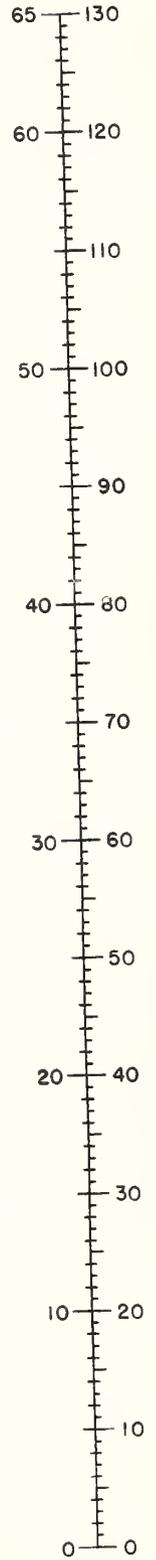
E ZONE

Fig.43.  
JANUARY

f°F2,  
Mc



F2-4000 MUF,  
Mc      SUNSPOT  
            NUMBER



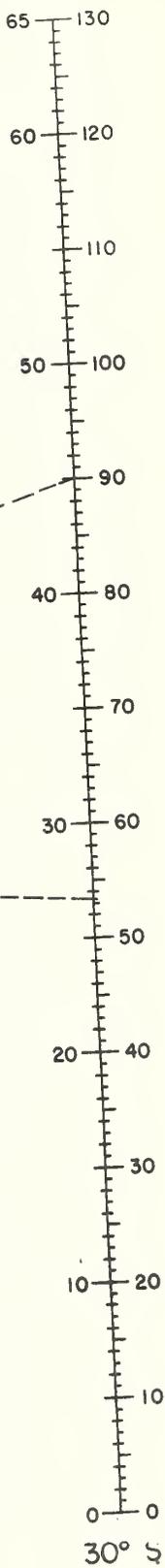
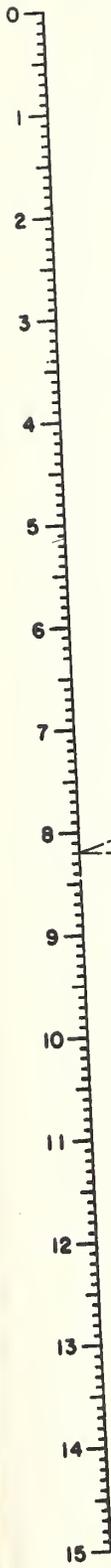
E ZONE

Fig44  
JANUARY

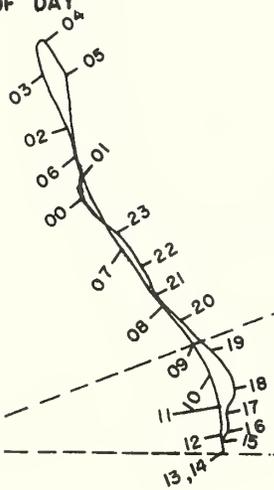
20° S

F2-4000 MUF, SUNSPOT NUMBER

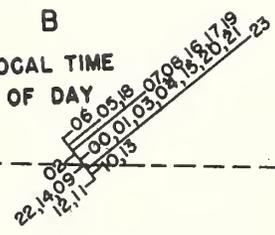
$f^{\circ}F_2$ ,  
Mc



A  
LOCAL TIME  
OF DAY



B  
LOCAL TIME  
OF DAY



Example:  
Sunspot Number = 90  
Local Time of Day = 0900  
 $f^{\circ}F_2 = 8.20$  Mc  
F2-4000 MUF = 26.6 Mc

E ZONE

Fig. 45.  
JANUARY

30° S



F2-4000 MUF, Mc      SUNSPOT NUMBER

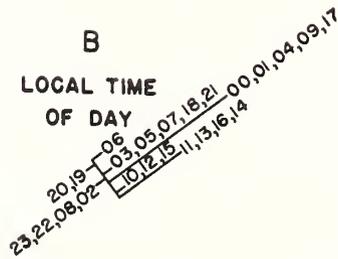
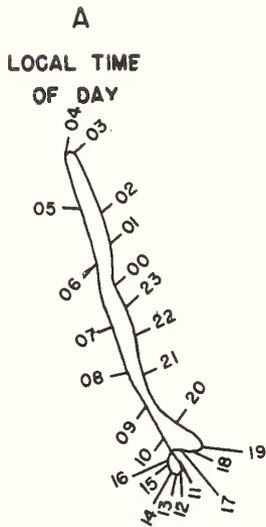
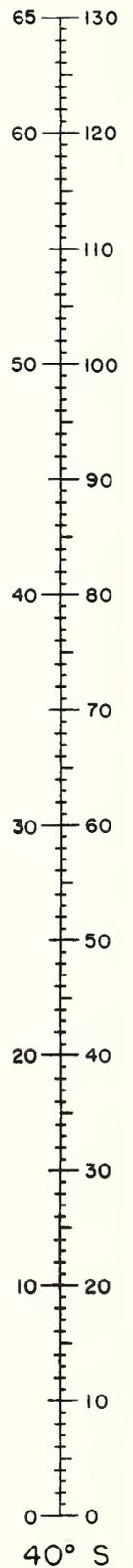
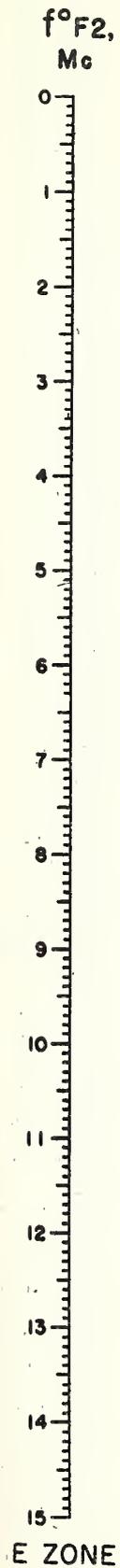
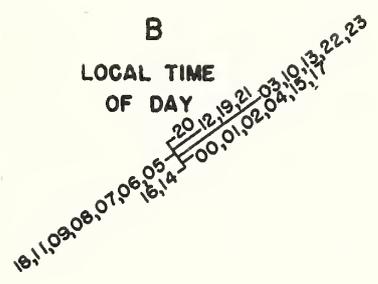
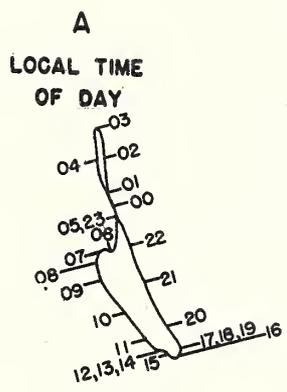
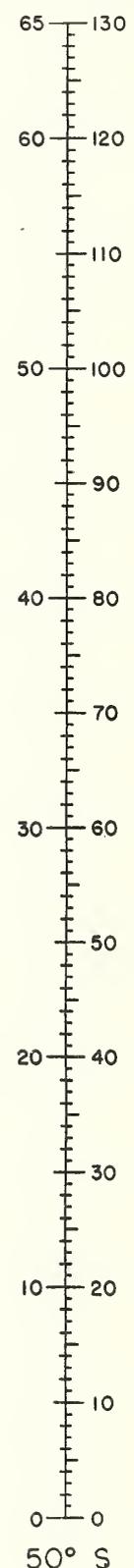


Fig. 46.  
JANUARY



F2-4000 MUF, SUNSPOT  
Mc NUMBER

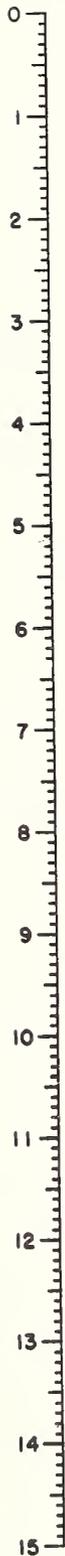


E ZONE

Fig. 47.  
JANUARY

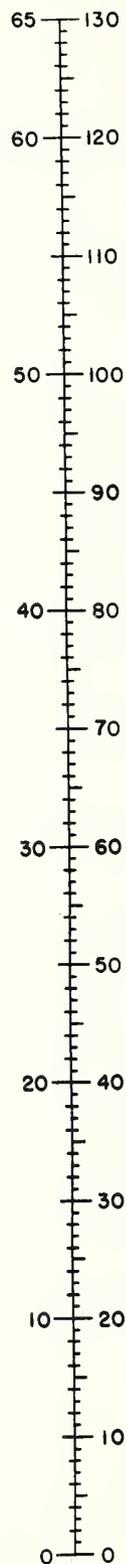
50° S

$f^{\circ}F_2$ ,  
Mc



E ZONE

F2-4000 MUF, SUNSPOT  
Mc NUMBER



60° S

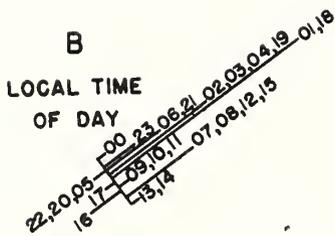
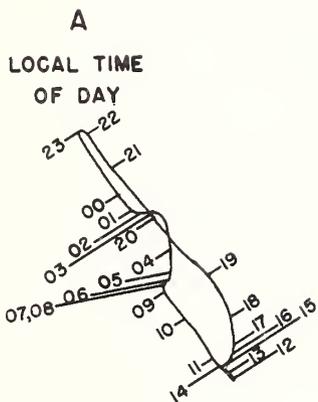
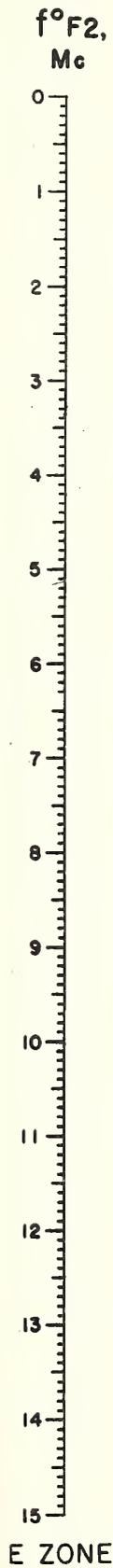


Fig.48.  
JANUARY



E ZONE

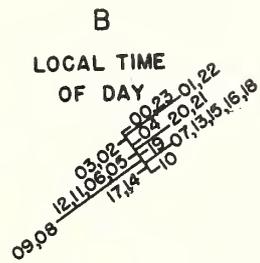
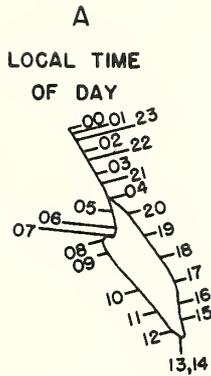
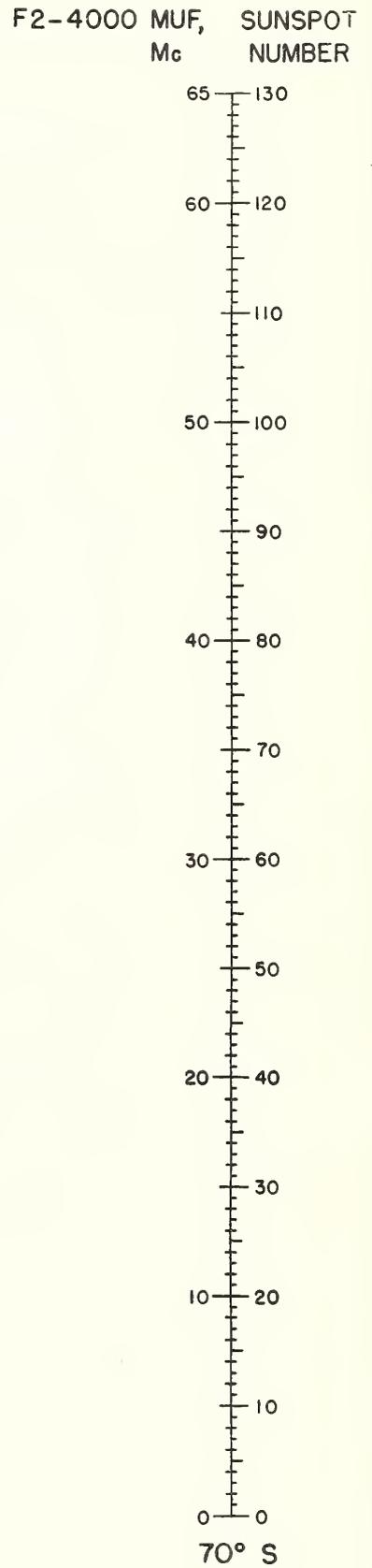


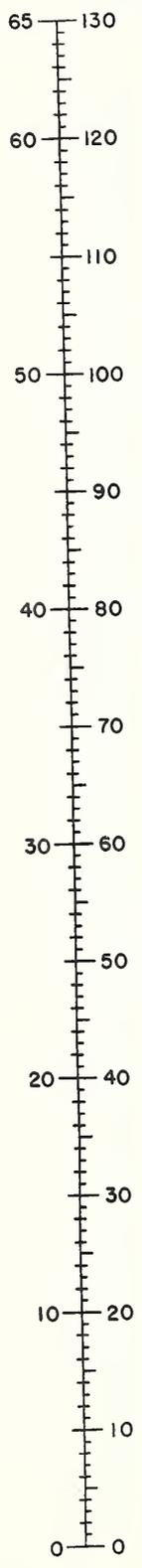
Fig.49.  
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$f^{\circ}F_2$ ,  
Mc



F2-4000 MUF, SUNSPOT  
Mc NUMBER



80° S

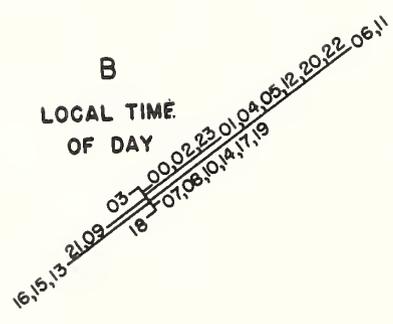
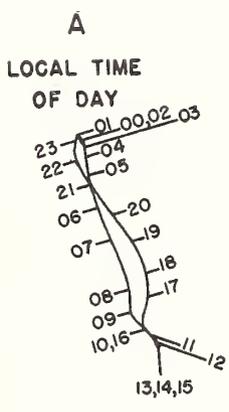


Fig.50.  
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